

PHOTOGRAPHIC ILLUSTRATIONS
OF THE
ANATOMY OF THE HUMAN EAR,

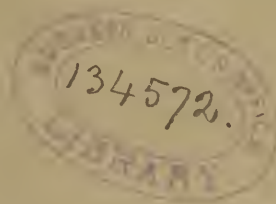
TOGETHER WITH
PATHOLOGICAL CONDITIONS OF THE DRUM MEMBRANE

AND
DESCRIPTIVE TEXT,

BY
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OPHTH. AND AURAL SURGEON TO THE P. EPISCOPAL AURAL SURGEON TO THE BOSTON DISPENSARY, AURAL EXTERNE
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PREFACE.

The beautiful photographs of the ear published by Prof. Rüdinger (*Atlas d. menschl. Gehör-organs*, Munich, 1866-1875), a portion of which have been republished in this country by Dr. C. J. Blake (*Rüdinger Atlas of the Osseous Anatomy of the Human Ear*, Boston, 1874), led the authors to attempt similar work: and the nucleus of this collection was made in the Winter of 1883, in Vienna, by the kind permission and with the personal assistance of Prof. Politzer, from some of the exquisite preparations in his private collection.

Since that time, through the kindness of Dr. C. J. Blake, photographs of his valuable private collection of preparations have been added; and the authors have also been allowed, by the courtesy of the Museum Committee of the College of Physicians of Philadelphia, to make use of the exceedingly interesting specimens in their possession, prepared and mounted by Profs. Politzer and Hyrtl. Microscopical sections and specimens belonging to Prof. Chas. H. Burnett and to the authors themselves, complete the list.

Some of the results of their work they now venture to make public, thinking that the large numbers of valuable specimens to which they have been so fortunate as to have access, present points of interest shown by no single collection. As the essential value of photography is in its absolute accuracy, they have entirely abstained from retouching the negatives; preferring that their pictures should show imperfections in point of beauty, or even more serious shortcomings, rather than labor under suspicion of being warped from the truth. Some "blocking out," however, has been done, in the interest of neatness and contrast. All of the photographs were taken by the authors themselves, under varying conditions as to light, etc., as many of the specimens could not be removed from the Museum to which they belonged, and some of them had to be photographed through glass—conditions greatly increasing the difficulty of obtaining entirely satisfactory pictures. It remains to note that specimens Nos. 43, 44 and 45 are from the collection of Prof. Politzer, in Vienna; specimens Nos. 40 to 42 and 46 to 63, inclusive, are from preparations of his in the Mütter Museum of the Philadelphia College of Physicians. Specimens Nos. 34 to 39 inclusive, are from preparations by Prof. Hyrtl in the same Museum. Specimens Nos. 4 and 10 to 31 inclusive, are from preparations belonging to Dr. C. J. Blake; and specimens Nos. 64, 65 and 67 from preparations in Prof. Burnett's collections. Specimens Nos. 3, 5, 6, 7, 8, 69, 71, 74 and 75 are from preparations belonging to Dr. Morse, and specimens Nos. 1, 2, 9, 66, 68, 70, 72 and 73 from preparations belonging to Dr. Randall—the authors' microscopical sections having been the gift of Prof. Politzer.

To the gentlemen who have so generously aided us in our efforts, we here tender our most hearty thanks: and we have also to thank Mr. C. H. James, Photographer, of Philadelphia, for the aid of his technical skill in the preparation of our results for publication.

OSSEOUS ANATOMY.

ILLUSTRATION NO. 1. Represents the outer surface of the right Temporal bone of an adult. The well-developed Mastoid process shows numerous roughnesses—the foramina for nutrient vessels, the points of insertion of muscles, etc. Behind and below it the Digastric groove may be seen; in front of it is the External Auditory Meatus. The formation of this bony tube by the conjunction of the anterior wall of the Mastoid, the root of the Zygomatic process and the scroll of the Tympanic bone or Auditory process is readily recognizable. The proximity of the shallow Glenoid fossa of the Mandibular articulation, shows the close relation of this joint to the ear; and how its movements affect the cartilaginous portion of the Meatus. The Styloid process is of small size and has been broken off quite short; but its position and the ensheathing of its base by the Tympanic bone is none the less distinct. The Stylo-Mastoid foramen, through which the Facial nerve makes its exit from the skull, is close beside it, but hidden from view.

ILL. NO. 2. Shows the inner surface of the same bone. The rough articular surfaces are seen all around its periphery—the beveled margin of the Squamous portion, which overlaps the Parietal, being conspicuous above. Below this can be seen the vague mouldings of the bone to the cerebral convolutions and the groove of the small meningeal artery. Projecting horizontally from the middle of the bone is the pyramidal Petrous portion, showing upon its prominent edge the groove for the superior Petrosal Sinus. Below this is the Internal Auditory Meatus; while more posteriorly is the sulcus of the Lateral or Transverse Sinus. At the bottom of the specimen can be seen the tips of the Styloid and Mastoid processes.

ILL. NO. 3. Presents an adult Temporal bone divided by a vertical, nearly coronal cut, passing through both auditory meatus. The posterior half, on the left, shows the Mastoid forming the posterior wall of the external Meatus and extending beyond and below it. The Meatus is separated by a plate of bone above from pneumatic cells which communicate with those of the Mastoid. At its inner end is seen the groove of the Annulus for the insertion of the Drum Membrane; and the downward turn of the axis of the canal just before reaching the Drum is very evident. To the right of the groove of the Annulus, is the Tympanic cavity or its posterior portion, separated from the cranial cavity above by the thin *Tegmen Tympani*, and presenting numerous irregularities of its surface, especially below. Its dark upper portion, or Attic, communicates

with the Mastoid Antrum behind it. A little cone of bone on its inner wall separates the Round from the Oval Window; while immediately above its base, is the little round opening into the Pyramid through which the Stapedius muscle extends its tendon to the head of the Stapes. To the right of this is half of the Oval Window—partly destroyed by the section, and no longer filled by the Stapes—looking rather like a part of the dark cavity to which it leads—the Vestibule. Above it is the Facial Canal cut transversely. Still further to the right is seen the Internal Auditory Meatus. On the other half of the bone the corresponding structures can be seen. The External Meatus is less distinctly bounded internally, only the lower portion of the groove of the Annulus being discernible. The projection of the Promontory, containing part of the first turn of the Cochlea, is conspicuous just above this groove, while to the left is seen the cribriform lamina, which forms the bottom of one division of the Internal Meatus and transmits the branches of the Acoustic nerve to the Cochlea.

ILL. NO. 4. Vertical section through the External Meatus and the Eustachian Tube. The specimen shows the posterior wall of the Meatus extending inward from the surface of the Mastoid to the Drum cavity. The thin roof of bone which separates the Tympanum from the cranial cavity is well shown; and just below it is the half-tubular scroll in which lies the Tensor Tympani muscle, ending in the ring through which the tendon turns abruptly forward for insertion on the Malleus handle. A little below and to the right the Stapes may be distinguished, occupying its normal position—its foot-plate filling the Oval Window. The dark niche of the Round Window is below; but the window itself is not visible. Just back of the head of the Stapes (to the right) may be seen a dark point at the top of a little bony prominence; this projection is the Pyramid, or *Eminentia stapedii*, within which the Stapedius muscle arises; and its tendon turns forward through the little opening at the summit, to be inserted on the head of the Stapes. Downward and to the left from the Drum cavity extends the bony Eustachian Tube, its extremities rough and uneven for the insertion of the cartilaginous portion of the tube. Further to the left is the irregular anterior extremity of the Carotid Canal.

ILL. NO. 5. Shows a curved section in a nearly vertical plane passing through the Mastoid, the Tympanic cavity, and the Eustachian Tube, of an adult temporal bone. The tympanic structures appear as in the preceding picture—the Pneumatic Cells of the Mastoid and their relations alone demand attention here. A portion of the Mastoid Antrum is visible above, and extending especially downward from this, are seen numerous cavities varying both as to their capacity and the thickness of their walls. Cells of considerable size occupy the tip of the Mastoid, leaving, however, a strong osseous plate to form the exterior surface of the bone. The sulcus of the Lateral Sinus has been opened, and the thinness of its walls and its close relation to the Mastoid cells are evident. This may be considered as a normal Mastoid, showing about the average relation of cavities and bony walls.

ILL. No. 6. Shows a sclerosed Mastoid, presenting a thick, dense plate of bone between the air cells and the outer surface. The pneumatic cells are numerous but small; and do not extend to the tip of the Mastoid process. The Antrum differs little from that of the other preparations; its variations being, as a rule, inconsiderable. Attention may be called to the delicate thinness of the plate of bone, here broken through, which separates the Eustachian tube from the Carotid canal; and in view of the fact that it may be incomplete and merely membranous in part, the caution with which a Eustachian bougie should be used need not be emphasized.

ILL. No. 7. The other extreme of the relation of the cavities of the Mastoid to the bony walls is seen in this specimen. The Mastoid is almost all cells; and its external walls, as well as the septa within, are of a paper-like thinness. The connection between the Tympanum and the Antrum is well marked; while the Lateral Sinus, again laid open, is seen to be very close to the Antrum.

ILL. No. 8. Anomalous Pneumatic Cells between the outer and inner tables of the Skull communicating with the Cells in the Mastoid. Below and to the left is the Mastoid process seen from behind and showing very little detail in this picture. Just above are seen the two tables of the skull, in this case 10 m.m. apart; and the space between is divided by thin bony septa into large pneumatic cells which communicate with those of the Mastoid. This latter is unusually translucent throughout, and seems to be made up of but two or three large, thin-walled cells. The pneumatic cells extend backward for more than 15 m.m. behind the posterior edge of the Mastoid process, ending there abruptly. Above and inward from the inner table of the skull is the Lateral Sinus, showing as a dark, shaded depression: the lower portion of the picture to the right shows the base of the skull in section.

ILL. No. 9. Curved vertical section through the Mastoid, etc. The cut, begun at right angles to the surface of the Mastoid at its middle, has been curved forward nearly in the plane of the Facial Canal and passes out through the Eustachian tube. A normally pneumatic Mastoid is seen, with several of its cells about as large as the Antrum. The section has passed through the Tympanic cavity, cutting off the head of the Stapes and flattening the prominence of the Promontory, as may be seen on the right side. The groove and canal by which the Petrosal nerve goes to join the Facial are clearly marked, and the *Aqueductus Fallopii* or Facial Canal is laid open from above the oval window to near its exit at the Stylo-Mastoid foramen. Just above it, near the Stapes, is seen the opened Horizontal Semicircular Canal with its ampullar enlargement, the convexity of the Canal showing on the other half of the specimen. In front of the descending part of the Facial Canal is seen the Pyramid or Eminencia Stapedii, laid open to show the conical tube which lodges the Stapedius muscle.

ILL. No. 10. Temporal bone of an Infant—outer aspect—amplified one and a half diameters. In the lower central portion of the picture is seen the Tympanic cavity, opened to view by the removal of the Drum membrane. Near the centre of its inner wall the Oval window is seen as an irregular ellipse, with its lower edge straighter than the upper. Below it is the dark niche in which lies the Round window. Above is the Attic of the Tympanum in shadow. Framing in these details is the Tympanic portion of the bone, extending as an incomplete ring from the root of the zygomatic process around nearly to the same point again, but leaving above and forward a small interval—the Rivinian Segment—where the thin edge of the Squamous portion completes the circle. The broad surface of the Squama extends from the Zygoma backward to the dark suture which separates it from that part of the Petrous portion which is later known as the Mastoid, because of the conspicuous process which marks it. This process, as yet undeveloped, can hardly be recognized in the little prominence immediately behind the lower part of the suture. Below the end of the suture is seen the foramen by which the Facial nerve leaves the skull, as yet showing little of the relation to the adjacent processes which, later, gives it so appropriately the name of Stylo-Mastoid.

ILL. No. 11. The Annulus or Tympanic portion of Temporal—inner aspect—one and a half diam. The bony ring, here separated, seems almost complete, the gap above being very narrow. Its inner edge is grooved for the insertion of the *annulus tendinosus*, from which the fibres of the *membrana propria* of the Drum membrane arise. Above and to the right is seen an obliquely-descending ridge, to which the long or *gracilis* process of the Malleus is applied, and later becomes adherent. The Chorda Tympani nerve and an artery also pass below the ridge.

ILL. No. 12. Squamous portion of the Temporal—inner surface— $\times 1.5$ diam. The lower part of the preparation shows a smooth surface which is a portion of the outer wall of the Tympanic cavity, its lower anterior edge being the Rivinian segment above mentioned. Back of this (to the left) can be seen rough cancellated bone—the outer wall of the Mastoid Antrum. Just above these is a thin projecting ridge of bone which constitutes part of the roof of the Tympanum.

ILL. No. 13. Petrous portion of Temporal—inner surface— $\times 1.5$. The bone shows in its anterior (right) part the dark *porus* of the Internal Auditory Meatus, by which the Acoustic and Facial nerves gain entrance to the Temporal. Behind and above this is the eminence which marks the position of the superior Semicircular canal; and in the anterior surface of this is the *Aquæductus Vestibuli*, which transmits a vein from the Vestibule. The upper edge is a thin plate of bone which forms the roof of the Antrum, the Tympanum and the Eustachian tube. Posteriorly is the sulcus of the Lateral sinus.

ILL. No. 14. Petrous portion opened to show the Tympanum and Labyrinth— $\times 1.5$. The bone is viewed from above, and as the roof of the Tympanum has been removed, the Tympanic cavity is opened to view; while the *scala* of the Cochlea and the turns of the Semicircular canals are also laid open. The same preparation, more enlarged, will be seen in Illustration No. 24, and there described more in detail.

ILL. No. 15. Adult Temporal from within, opened to show the Drum membrane and Ossicles. This picture shows the inner surface of the *Membrana Tympani*, with the Malleus, Incus and Stapes in position—the Petrous portion having been removed. The head of the Malleus and body of the Incus are seen to occupy the Attic of the Tympanum, back of which (to the left) is seen the dark Antrum and the communicating cells of the Mastoid. The handle of the Malleus is seen extending down and back to the centre of the Drum membrane, while its gracilis process passes down and forward into the Glasserian fissure. Accompanying this last can be seen the white Chorda Tympani nerve, which may be traced forward from near the Stapes, where it enters the Tympanum after passing up from its origin in the Facial nerve.

ILL. No. 16. Drum membrane and Ossicles of the preceding— $\times 2$. The same specimen is here seen more enlarged and with a different illumination. The articulation of the Malleus and Incus is here better shown, as also other minor details. The sulcus of the Lateral Sinus is more readily seen, its depression being marked by the dark shadow to the right. In the enlargement the specimen has been reversed.

ILL. No. 17. The Drum membrane, Annulus, Malleus and Incus of an Infant— $\times 4$. The specimen is viewed from within, and shows the inner surface of the Membrane slightly lighter than the background and flecked with little spots of dust. A perforation just back of the Malleus handle is probably due to a post-mortem injury. The rounded head of the Malleus, as well as its handle and long process, are distinctly seen. Behind it is the Incus, its short horizontal process much foreshortened; while its long, descending process, in strong relief against the Drum membrane, shows very clearly at its extremity the orbicular process which articulates with the Stapes.

ILL. No. 18. Annulus and Ossicles of an Infant— $\times 3$. This specimen, similar to the preceding and also viewed from within, is from the opposite ear, and shows the Annulus, its Drum membrane gone, with the entire chain of the Ossicles. The latter are well shown in almost all details, especially the Stapes, with its foot-plate directed toward us but inclined upward and to the left.

ILL. No. 19. Annulus tympanicus of Infant, separated— $\times 3$. The outer aspect of the bony ring is here shown, more enlarged than in the preceding Illustration, No. 11, and with a very decided gap above between its *spina antica* and *postica*. The abrupt square ending of the anterior spine contrasts with tapering bend of the posterior. The groove for the Drum membrane is almost entirely hidden in this view.

ILL. No. 20. Bony Semicircular Canals, separated, with the Stapes in position— $\times 3$. This and the succeeding picture show the Semicircular canals of the right and left ears, respectively, of an Infant. They are in a sense inverted, since the Superior Canal in each projects downward. The Stapes is seen in each, filling with its foot-plate the oval window. Close above it (below in the picture) is the ampulla of the Horizontal canal, almost joining that of the Superior. A portion of the first turn of the Cochlea is retained on the left in 20. In 21, the Canals and their Ampullæ have been laid open and their communication with the Vestibule is seen. The same specimen is further enlarged in Illustration No. 25.

ILL. No. 22. Semicircular Canals viewed from the Vestibule— $\times 3$. The openings, five in number, by which the Semicircular Canals communicate with the Vestibule, are here well seen, and bristles thrust through the tubes indicate which are which. Two bristles may be seen coming from the upper right-hand opening, since this belongs to the common canal of the Superior and Posterior Canals.

ILL. No. 23. Opened Cochlea seen from above its Cupola— $\times 3$. The canal of the Cochlea is seen to begin at the Round Window, of which a part remains below and to the left, and to wind two and a half times around its axis. The bony ridge of the *Lamina spiralis* projects into its lumen and follows its windings, to end in the centre in the hook-like *Hamulus*.

ILL. No. 24. The Petrous portion laid open to show the Labyrinth— $\times 3$. The preparation is viewed very nearly from above, thus bringing the Superior Semicircular canal to the lower part of the picture. The Cochlea shows two of its turns and an opening into the half-turn above. Most important is the Facial Canal near the base of the Cochlea, partially laid open and occupied by a black bristle. It is seen to be directed backward (toward the right), and to pass close alongside of the Horizontal Semicircular canal. Just beyond it, but hidden from view, is the Oval Window.

ILL. No. 25. Opened Semicircular Canals and Stapes— $\times 5$. The preparation illustrated in 21, is here seen further enlarged, and needs no further description.

ILL. No. 26. Section through the Vestibule, Internal Meatus and Cochlea— $\times 5$. The cut divides the Cochlea nearly from its cupola to its base, yet leaves intact its conical axis, the Modiolus, with the *Lamina spiralis* projecting from it. The Stapes occupies the Oval window, of which the upper edge has been removed. Attention is especially called to the space between the bony shell of the Cochlea and the surrounding Petrous—evidence of the independent development of the former around the cochlear tube.

ILL. No. 27. The Bony Labyrinth of the right side, separated— $\times 5$. The entire bony shell of the Internal Ear has been removed from its investment in the Petrous. The

snail-like Cochlea is seen on the right, its turns beginning at the Round window and extending to the Cupola. The Semicircular Canals stretch to the left; while in the middle is the Vestibule, into which the Oval window opens. This latter is seen as a narrow slit just below the commencement of the Horizontal Canal; the Round window is out of sight below it, but its position is recognizable. Up and to the right is the Facial Canal cut across; its continuation, which bends backward and downward around the upper margin of the Oval window, having been removed. The junction of the Superior and Posterior Canals into a single, common tube is visible up and to the left.

ILL. No. 28. Bony Labyrinth of the left side, separated and laid open— $\times 5$. In the Cochlea can be seen the *hamulus* or tip in which the *Lamina spiralis ossea* ends, after having passed up through all the whorls of the canal, dividing it into its two *scala*. This division is completed by the membranous septum, absent in the preparation, which is so important as the substratum of Corti's Organ. The two portions into which the canal is thus divided are known as the Scala Vestibuli and the Scala Tympani. The former can be clearly seen to pass into the Vestibule; the latter, lying below the Lamina, passes toward the Tympanic cavity, but is cut off from it by the *Membrana Tympani secunda*, which closes the Round window. The ampullar dilations of the Semicircular Canals as they enter the Vestibule are well shown. The open Fallopian Canal of the Facial nerve, cut transversely, is again conspicuous above.

ILL. No. 29. Section through the Internal Meatus and Labyrinth— $\times 5$. The section passes through the Cochlea and the Meatus internus, much as in 26; but the Semicircular Canals are present and laid open. The conical axis around which the turns of the Cochlea are wound, the Modiolus, shows better here than elsewhere.

ILL. No. 30. Base of Cochlea and cribriform bottom of the Internal Meatus— $\times 4$. Here we see the lower turn of the Cochlea laid open and to the right of it the Meatus internus. This ends on the left in the sieve-like plate which allows the fibres of the Cochlear branch of the Acoustic nerve to enter the Modiolus for distribution within the Cochlea: on the right it ends more blindly, but similar perforations transmit the branches of the Vestibular portion of the Acusticus to the Vestibule and Ampullæ. Above is the small dark beginning of the Fallopian Canal by which the Facial nerve, *Portio dura*, passes out of the cranium.

ILL. No. 31. Infant's Cochlea separated from the surrounding Petrous— $\times 4$. This shows very prettily the open cancellated bone which, in early infancy, unites the bony Cochlea with its surroundings, as seen in 26.

ILL. Nos. 32 AND 33. Annulus, Ossicles and Labyrinth, seen from above— $\times 3.5$. These pictures show the relation of the Labyrinth to the Annulus, Drum membrane and Ossicles. The Membrane appears white in 32, with the Malleus handle extending downward to its centre. In 33, the preparation has been turned, in order to show the

tendon of the Stapedius muscle inserted upon the head of the Stapes. (Both pictures are from the same specimen, but an accidental inversion of one was made in enlarging.)

ILL. No. 34. Set of Ossicles of Infant, articulated— $\times 6$. The Ossicles of the left ear are viewed from their inner side, the foot-plate of the Stapes extending almost directly toward us. The irregular oval form of this foot-plate, the grooved crura which unite it with the head of the ossicle, and the articulation of this head with the long or descending process of the Incus, may be plainly seen. The short or horizontal process of the Incus extends to the left, somewhat foreshortened in this view, its tip showing a vague articular facet. The Malleus shows its rounded head, the long *processus gracilis* extending forward and downward from its neck, and its stout handle, or Manubrium, into the upper anterior part of which, close below the root of the long process, the tendon of the Tensor Tympani is inserted. The short process, so distinctly visible in the examination of the healthy ear in life, is turned from us and hidden by the gracilis process.

ILL. No. 35. Set of Normal Ossicles of a Youth, disarticulated— $\times 5.5$. Little need be added to the previous note. The ossicles are from the right ear, again viewed from within. The upper and lower "cogs" of the articulation of the Incus, upon which Helmholtz lays stress, are plainly seen—the upper facing inward, the lower outward. The lenticular or orbicular process at the tip of the long process of the Incus, which forms its articulation with the Stapes, is not well marked (vide 17). This is, in embryonic life, a separate Ossicle, and sometimes unites with the Stapes instead of with the Incus. Two anomalous little knobs are seen upon the body of the Incus near its centre.

ILL. No. 36. Annulus and sets of Ossicles of the Infant— $\times 3$. The set of ossicles to the right is the same which is shown more enlarged in 34, but seen from a slightly different point. The set to the left is seen from the outer side, and shows that the foot-plate of the Stapes has the continuation of the grooves, seen above in the crura, for the insertion of the tiny Obturator membrane. The entire set has been rotated so that the horizontal process of the Incus points nearly down. The central set shows its relations to the Annulus much as in Illustration 18.

ILL. No. 37. Set of Ossicles showing Necrosis of the Malleus and Incus— $\times 5$. The Stapes, the most important of the chain of Ossicles, has escaped injury: but the Malleus has lost its long and short processes and most of its articular surface; while the Incus is similarly damaged, and has lost almost all of its short process and the tip of its long process.

ILL. Nos. 38 AND 39. Anomalies of the Annulus and Ossicles from human Monstrosities— $\times 2$. Detailed notes as to the deformities here shown are needless, having more interest to the student of Comparative Anatomy, as approximations to lower types, than to the aurist. The Stapes is most often deformed, as in congenital deaf mutes.

DRUM MEMBRANE PREPARATIONS.

ILLUSTRATION No. 40. The Drum Membrane in Normal Condition— $\times 3$. The bony as well as the soft parts of the Meatus ext. having been removed, the illumination is general and the reflections from the membrane are not limited nor defined, as when examined in life. Up and posteriorly (*i. e.*, to the left—this representing the right membrane) is seen part of the Meatus wall, showing that our line of view is much more perpendicular to the plane of the membrane than is the axis of the Meatus. The Light Spot below and anteriorly occupies nearly the normal position; but is not the typical triangle in form, its apex near the Umbo—the centre of the Membrane. The Malleus handle or Manubrium is seen extending downward and backward to the centre of the membrane, its curves and its normally indrawn position showing less markedly than when studied from the direction of the axis of the Meatus. Its Short Process shows at its tip the usual dull-white point; behind it is a conspicuous reflection nearly over the posterior fold, having none of the pathological significance, however, which it would have in life. The membrana flaccida, or Schrapnell's Membrane, above the short process is well defined by the two suspensory ligaments, here appearing dark, in contrast to the reflecting membrane. The picture is inserted here, not as representing a typical clinical life-picture of the Membrana Tympani, but as free from gross pathological lesions, and furnishing a standard of comparison for the various abnormal conditions which follow.

ILL. No. 41. Ragged Perforation of the M. t., with Chalk in its lower margin— $\times 3$. The perforation is situated close below the Manubrium tip, its long axis about 30° . Inspection of its uneven edges raises a suspicion that it may have been accidentally enlarged post-mortem; but the chalk deposit in its edge shows that part at least of it is not only pathological, but is not recent. The *annulus tendinosus* is seen as a white margin up and back, its entire extent being calcified.

ILL. No. 42. Small Perforation up and posteriorly; Chalk Deposit below it— $\times 3$. The perforation occupies rather an unusual place, the Membrane being at this point especially strong and resisting; thus illustrating the clinical importance of the Pouches of the M. t. The upper edge of the opening is traversed by the Chorda Tympani nerve, though this is, unfortunately, not manifest in the picture. The calcification has the usual rounded crescentic form, but is less snowy white than is often seen.

ILL. No. 43. Small Perforation in lower part of M. t., seen from within— $\times 2$. The opening is in the position probably most frequently so occupied, and has the common oval form. The Malleus and Incus are well seen above, the Annulus in this and the succeeding two preparations having been removed from its bony surroundings.

ILL. No. 44. Perforation of lower part of M. t. with chalky Deposits— $\times 2$. The opening here differs only in size from the preceding; the chalk deposits occupy the upper posterior portion. The Malleus remains in position, the Incus having been removed.

ILL. No. 45. Calcification of the M. t., Perforation up and back, Necrosis of long process of Incus— $\times 3$. This remarkable preparation is pictured in Fig. 175 of Prof. Politzer's Text-book, the outer surface of the almost identically similar *right* membrane being shown in Fig. 139. The drum membrane has almost throughout been transformed into a dense plate of chalk: only the annulus tendinosus, the immediate neighborhood of the Manubrium, and the edges of the perforation being exempt. Thus utterly deprived of all use as a "membrana vibrans," and precluding all function of the Malleus and Incus, it would have been a great obstruction to the hearing, had not the perforation remained open, allowing the waves of sound free access to the tympanic cavity. The necrotic process which has attacked the Incus has, fortunately, destroyed its articulation with the Stapes, setting free that most important ossicle (perhaps only its foot-plate remained), to respond as of old to vibrations. Hence the astonishing result that the patient with two such ears could hear a loud whisper from a distance of 18 metres. An unfortunate fracture of the negative mars this picture.

ILL. No. 46. Double Perforation of the Drum Membrane— $\times 3$. A large irregularly oval opening is seen to occupy the major portion of each lateral half of the Membrane. The Malleus handle retains its normal position, being held by a triangular band of thickened membrane stretching up from below. Near the upper extremity of the posterior perforation can be seen the tip of the long process of the Incus. The Stapes is in normal position, concealed by the upper edge of membrane.

ILL. No. 47. Double Perforation of the Drum Membrane— $\times 3$. This preparation differs in no great degree from the last, but is from the other side of the body. The Manubrium is much more plainly seen, unobscured by thickening of the remains of the Membrane, its flattened tip presenting a very marked turn forward, like a gum-lancet.

ILL. No. 48. Triple Perforation of Drum Membrane with Chalk Deposit anteriorly— $\times 3$. There is hardly a trace of the posterior half of the Membrane in this preparation—merely a sickle-shaped edge below; while above only the posterior fold, strengthened by the Chorda Tympani, separates this opening from another involving the Memb. flac. and all adjacent portions, and revealing the neck and part of the head of the Malleus. A small perforation is seen in front of the Manubrium, with a chalk mass below it. The niche of the round window is visible down and back as a dark recess. The Stapes occupies the oval window, but the little articular surface of its head is hardly discernible—although necrosis of the long process of the Incus has set it free from its articulation with that ossicle.

ILL. No. 49. Perforation posteriorly and Cicatrix anteriorly— $\times 3$. All of the Drum Membrane has been destroyed except a narrow band extending upward to the Manubrium from the narrow rim below. The rounded posterior perforation remains open, showing the wall of the Promontory within; the anterior opening has been closed by a strong cicatrix.

ILL. No. 50. Scattered Chalk Deposit in lower half of Drum Membrane— $\times 3$. The Malleus handle stands out in very pronounced manner above the general plane of the membrane. The Chalky masses form an irregular broken crescent, broader anteriorly.

ILL. No. 51. Dense Chalk Deposit in posterior half of Membrane—Cicatrix in front of Manubrium— $\times 3$. The thick snowy mass of chalk seems to stand out prominently from the thin and rather atrophic Membrane. The anterior half of the membrane shows the site of a vertically oval perforation, now closed by a delicate scar. The Membrane is retracted, giving marked prominence to the posterior fold and foreshortening the Malleus handle.

ILL. No. 52. Extensive Destruction of M. t., with Chalk Deposit— $\times 3$. Nearly half of the Malleus handle has been laid bare by the loss of the Membrane; but it has been saved from the Caries, which is apt to be its lot under such circumstances, by its adhesion to the Promontory. A mere edge of Membrane remains, except above; there it is thickened and deformed by Chalk deposits—its posterior part adherent to the Inco-Stapedial joint. The Stapes, which forms the prominence to the right of the Manubrium, is ankylosed and held fast by bony trabeculæ, of which a delicate one is conspicuous below it.

ILL. No. 53. Almost complete Destruction of M. t. replaced by Cicatrix— $\times 3$. Examination of the almost complete membrane shows that only a narrow edge of the original membrane remains, except a triangular band down and forward, as in 48. The double perforation has been closed, however, by thin new tissue, granular-looking in the picture, and eyeleted by several openings (probably post-mortem). The curious abrupt turn of the Malleus handle suggests fracture and displacement, and may point to traumatism, with rupture of the Drum membrane, as the starting point of the condition. A small perforation above the short process remains open.

ILL. No. 54. Destruction of M. t.—Manubrium adherent to the inner wall of Tympanum— $\times 3$. Only a narrow crescent of the Membrane is to be seen below, and this partly thickened and calcified. Above, the neck as well as the handle of the Malleus is seen bare and exposed. The tip of the Manubrium is fast to the Promontory and a delicate new membrane, barely discernible in the picture, extends forward from it to join the edge of the Membrane there remaining. The Incus and Stapes are gone, but the foot-plate of the latter may be preserved beneath the membrane which conceals the Oval window.

ILL. No. 55. Destruction of M. t.—New membrane closing the Eustachian Tube— $\times 3$. This specimen resembles the preceding in most respects; but presents a new membrane entirely independent of the M. t., which completely shuts off the Tympanum from communication with the Eustachian tube. This membrane (to the demonstration of which all other detail has been sacrificed) is seen as a light oval, down and to the left—light having been thrown upon it from its tubal side.

ILL. No. 56. Destruction of the M. t.—Bony Ankylosis of the Stapes— $\times 3$. The loss of the greater part of the Membrane, shows the Malleus handle fast to the Pro-

montory; while behind and above it the long process of the Incus is seen fast to a bony prominence, with a fenestrated base. Inspection proves this prominence to be the Stapes, ankylosed into the Oval window, and converted into a solid conical mass by arching bony trabeculae from the surrounding walls.

ILL. No. 57. Caries of the Rivinian Segment and of the Malleus head.—Dislocation of the Malleus and loss of the Incus— $\times 3$. Quite a loss is seen, above, of the edge of bone which constitutes the outer wall of the tympanic Attic as well as the point of origin of the memb. flac. The Malleus has undergone necrosis of its articular surface and the Incus, thus loosened from its principal attachment, has been lost. The Stapes, apparently uninjured, occupies its normal position in the Oval window; but the Malleus is dislocated forward. Just below the Malleus is seen the pulley of the Tensor Tympani.

ILL. No. 58. Strongly indrawn M.t., profile view— $\times 3$. The pyramid of the Petrous has been cut away as far back as the internal Meatus and the front wall of the Tympanum removed, opening that cavity well to examination. To the inner side (left) is seen the opened Promontory, and above it the Stapes, in position and articulated with the Incus. In front of this is the Malleus handle, drawn deeply into the tympanic cavity and with its tip almost free from the Drum membrane, which is seen stretched in to it as a steep tent-shaped cone.

ILL. No. 59. Cicatrix of M.t. indrawn and fast to Promontory, profile view— $\times 3$. Much as in the preceding preparation, the M. t. is seen strongly retracted, most specially a portion below the Manubrium tip, which adheres to the inner tympanic wall. The front view of the same preparation is shown in 60, the retracted portion being there seen to constitute but a small perforation-like area down and back from the Umbo.

ILL. No. 61. Indrawn M.t. with Chalk Deposit and small central Perforation— $\times 3$. The Drum membrane, in most respects not greatly abnormal, gives evidence by its perforation and the calcification, that it has been affected by an Otitis media. The point, however, to which attention should be directed, is a vague line around its circumference near its insertion, which marks the sharp transition from the unchanged plane of the stiff annulus tendinosus to the indrawn general surface of the Membrane—the “Knickung” of German writers.

ILL. No. 62. Extensive Destruction of M. t.—Manubrium fast to Promontory— $\times 3$. The perforation involves almost the entire membrana vibrans, setting free the Malleus handle, which has become attached to the inner wall of the tympanic cavity.

ILL. No. 63. Destruction of M.t.—New Membrane closing the Eustachian Tube— $\times 3$. This preparation closely resembles Ill. 55; but its Eustachian tube not having been laid open to permit lighting it from that side, the new membrane appears dark. Like the other, it is independent of the Drum membrane and completely occludes the mouth of the tube.

MICROSCOPICAL PREPARATIONS.

ILL. No. 64. Transverse section of the Helix of the External Ear— $\times 14$. The section is from the upper posterior portion of the Auricle, and shows the bent fibro-cartilage, rather bulbous near its extremity, clothed by its two layers of integument. This latter is less closely adherent here than at most other parts of the uricle, and the loose sub-cutaneous tissue shows some deposit of fat. A few delicate sweat and sebaceous glands are to be seen, and the bulbs of the delicate downy hairs.

ILL. No. 65. Transverse section of the cartilaginous Meatus Externus— $\times 14$. The lumen of the Meatus is visible to the left and above, with hairs projecting into it. The skin from which they arise shows their bulbs and sebaceous glands; while below are the ceruminous glands, so massed as to suggest a racemose structure. The plate of the fibro-cartilage of the meatus with its fibrous perichondrium, completes the picture.

ILL. No. 66. Transv. section of the Membrana Tympani and the Malleus handle— $\times 15$. The preparation shows the Drum Membrane in section, enclosing between its surfaces the triangular malleus handle. The component layers of the membrane cannot be discerned; but its transition into the "annulus tendinosus," and the insertion of this into the shallow groove of the bony Annulus, is easily recognizable.

ILL. No. 67. Flat preparation of the Drum Membrane— $\times 30$. The radiating and the circular fibres of the Membrana propria have been brought clearly to view by the removal of both the cutaneous and the mucous coverings of the Membrane. The preponderance of the radiating fibres is distinctly visible.

ILL. No. 68. Transv. section of the Eustachian Tube— $\times 15$. The section shows the form of the "hook cartilage" in its entirety and its intimate relation to the more patulous upper portion of the tube. The lumen of the tube is seen as a narrow cleft, invaded here and there by projecting folds of its mucous membrane, and surrounded by abundant racemose glands. The cells of the fibro-cartilage are vaguely seen and their aggregation into stellate masses gives the curious mottled aspect to the cartilage. The fibres of the Tensor Palati are visible in front of the tube, arising in part from the hook of the cartilage; but many of its fibres pass upward to find an insertion above, and a bursal sac is evidently interposed between them and the prominent tip of the cartilaginous hook. The inmost layer of the muscle (Weber-Liel) shows fibres cut almost transversely. Beneath the floor of the tube, the Levator Palati is seen in transverse section, as a dark rounded mass.

ILL. No. 69. Transv. section of a Semicircular Canal— $\times 20$. The preparation shows a Bony Semicircular Canal, surrounded by the less dense tissue of the Petrous

bone, and only partially differentiated from it by its less open structure. Within its lumen is the eccentrically placed Membranous Canal, fast to the distal side of its curve, but unsupported by the coarse network of fibres which is usually to be seen subdividing the tube. The membranous canal seems little more than a delicate circle, showing none of the ridges of its lining epithelium which are to be seen in good preparations.

ILL. No. 70. Membranous Semicircular Canal and its Ampulla; flat preparation— $\times 20$. The thin-walled tube of the Canal is lined with epithelium, indistinguishable with the low amplification, except that its rugæ give a mottled appearance. The pear-shaped swelling of the Ampulla is somewhat exaggerated by the flattening under the cover glass, and shows its epithelial lining partially detached in flakes. Portions of the wall of the Utricle adhere at the open end of the Ampulla.

ILL. No. 71. Horizontal section of the Malleo-Incal Joint— $\times 18$. The cut passes through the head of the Malleus and the body of the Incus, extending out to the tip of the horizontal or short process. The anterior ligament of the joint is strongly marked; posteriorly the capsular ligament and the triangular elastic mass which passes in between the articular surfaces may be distinguished. The amplification is not sufficient to make clear the ensheathing of the articulating faces with cartilage, nor the periosteal and mucous coverings of the ossicles, although these points can be vaguely discerned.

ILL. No. 72. Cochlea of Embryo, in 4th month, in longitudinal section— $\times 18$. The cut, not quite central, shows the cartilaginous Petrous traversed by two turns of the *Ductus Cochlearis*, the bony Cochlea being very rudimentary. Only the Modiolus shows evidence of commencing ossification; but the complete development of the *Lamina spiralis membranacea* and other essentials of the Cochlear Canal is recognizable in the first turn, in spite of the imperfections of the specimen.

ILL. No. 73. Cochlea of Infant, longitudinal— $\times 16$. The Cochlea is here seen fully developed, the ossification of the walls and of the Modiolus completed, and the Acoustic nerve entering for distribution. The division of each turn into its vestibular and tympanic Scala is well marked, but the loss of Reissner's Membrane leaves the Ductus Cochlearis undifferentiated. The Organ of Corti has not been preserved. The independence of the Cochlea of the surrounding Petrous is marked. In the left upper turn Reissner's Membrane is well preserved, although the *Lamina spiralis* is lost.

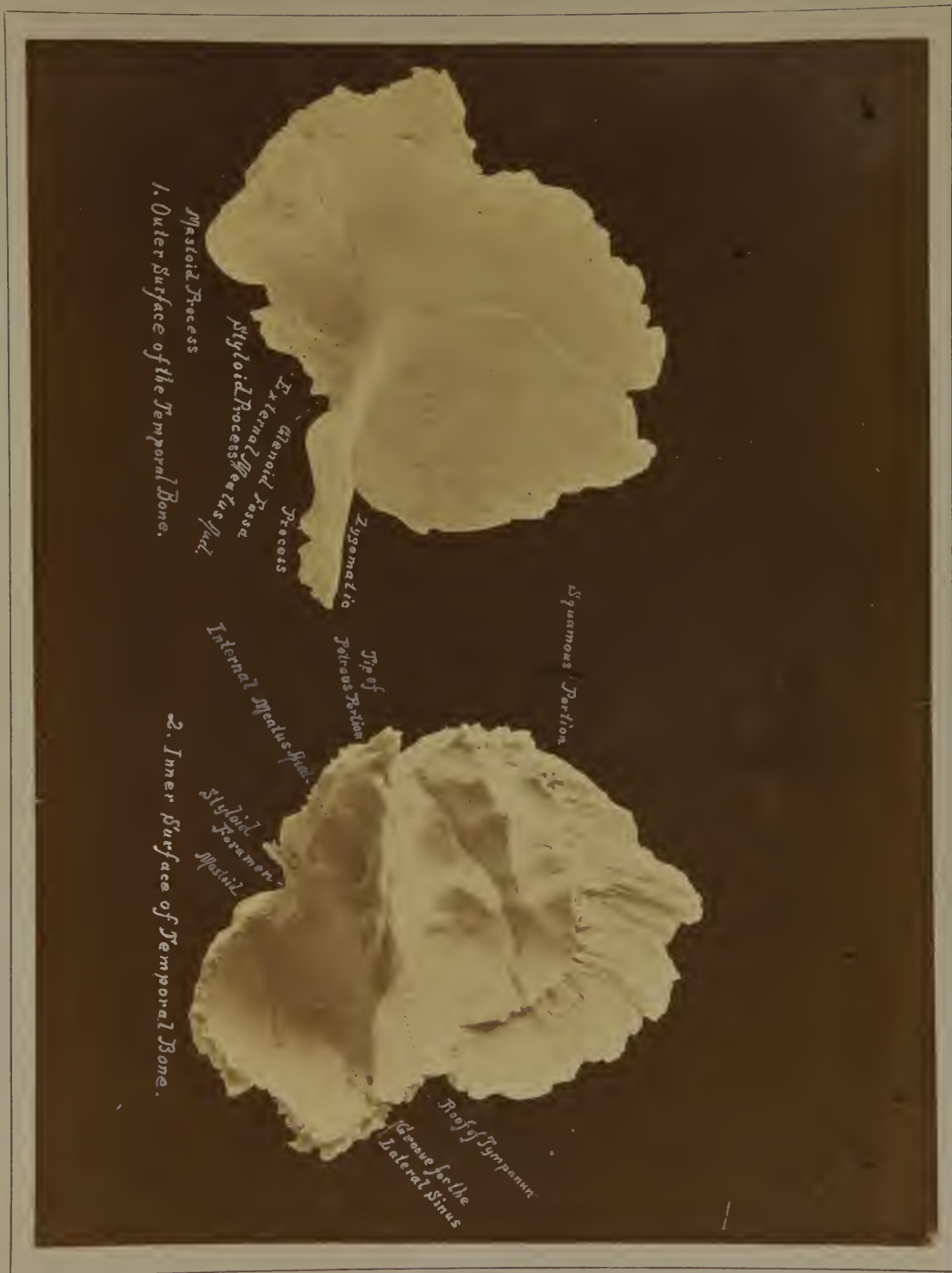
ILL. No. 74. Single turn of the Cochlea of a Child— $\times 31$. The strong bony wall of the Cochlea is now almost entirely fused with the surrounding Petrous bone, while the Modiolus seems rather more delicate and channeled out by vascular canals than in the infant. The length of the *lamina spiralis ossea* shows this to be the first turn of the

Cochlea: the bundles of nerve-fibres which traverse it are readily seen, although their connection with the *Ganglion spirale*, which occupies the circular space to the left, is interrupted. The Membrana basilaris is seen reaching across to the Ligamentum spirale on the opposite wall, and completing the division of the canal into its vestibular and tympanic Scala; but the delicate Membrane of Reissner is torn loose and floats as a delicate veil in the Scala vestibuli. Its points of origin and insertion are unmistakable, however, and a dotted line has been drawn across to indicate its proper position and the upper limit of the Ductus Cochlearis. It is seen to arise from the inner portion of the Crista spiralis, and to be inserted on the upper part of the Ligamentum spirale (Kölliker) just above the broad dark band, which is the deformed Stria vascularis. The Membrana tectoria, or Corti's Membrane, is lost. The seat of Corti's organ upon the Membrana basilaris is stripped almost bare, only a few of the Inner and Outer Pillars remaining to mark the position and size of the arch which they form. The Hair Cells or Hearing Cells and their secondary structures have not been preserved.

ILL. No. 75. The Organ of Corti of an Infant— $\times 120$. The well preserved structure has been displaced into a lower turn of the Cochlea and lies close to the bony trabeculum forming its floor. The Membrana basilaris, torn loose from its attachment to the Lig. spirale, has lost its rectilinear direction, but is otherwise normal. The delicate cells which cover its tympanic side are somewhat disturbed and heaped together, especially just below Corti's arch. Two of the Outer Pillars and the base of a third are easily distinguishable; the Inner Pillars are less distinct, and their heads seem to fuse with those of the outer. The *lamina reticularis* extends outward from them as a heavy, dark line, above which can be seen the cilia of Corti's Cells loaded with granular debris. The bodies of these cells below are not readily distinguished, and it is impossible to say whether we have here three or four. Their position and direction and the fact that the lower element of each, the cell of Deiters, is inserted upon the Membrana basil. is unmistakable. The large and rather globular Cells of Claudius are seen lining the inner sulcus and passing up between the teeth of the Crista spiralis to join the row of cells whose nuclei are seen along the top of that structure. The membr. tectoria or Corti's Membrane is displaced upwards: its origin from the tip of the Crista spiralis, its thick middle portion and its more delicate retracted end, are all easily seen. Neither this nor any other preparation studied, shows its attachment to the ligamentum spir. access. The globular supporting cells external to Corti's Organ show the fat globules often found in this situation. The Acoustic nerve is not easily recognizable within the Lamina spiralis, but some of its fibrils can be seen crossing the tunnel of Corti on their way to the outer hearing cells.

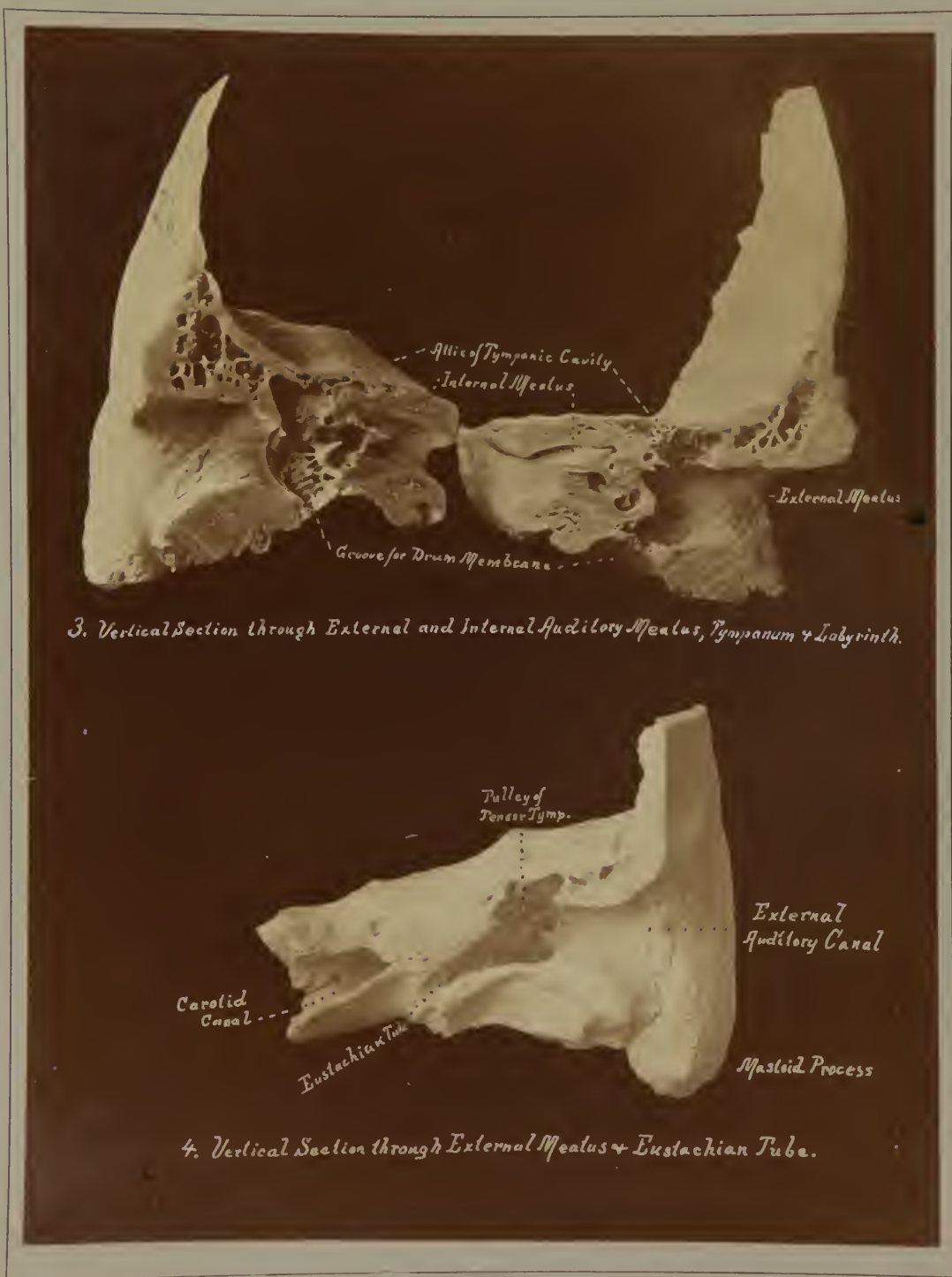
The diagram below is based upon a careful drawing with the camera of the foregoing specimen, supplemented, where necessary, by details taken from other preparations; and will probably be an aid to the understanding of the four previous specimens. Its amplification also is about 120.

Photographic Illustrations of the Anatomy of the Ear.



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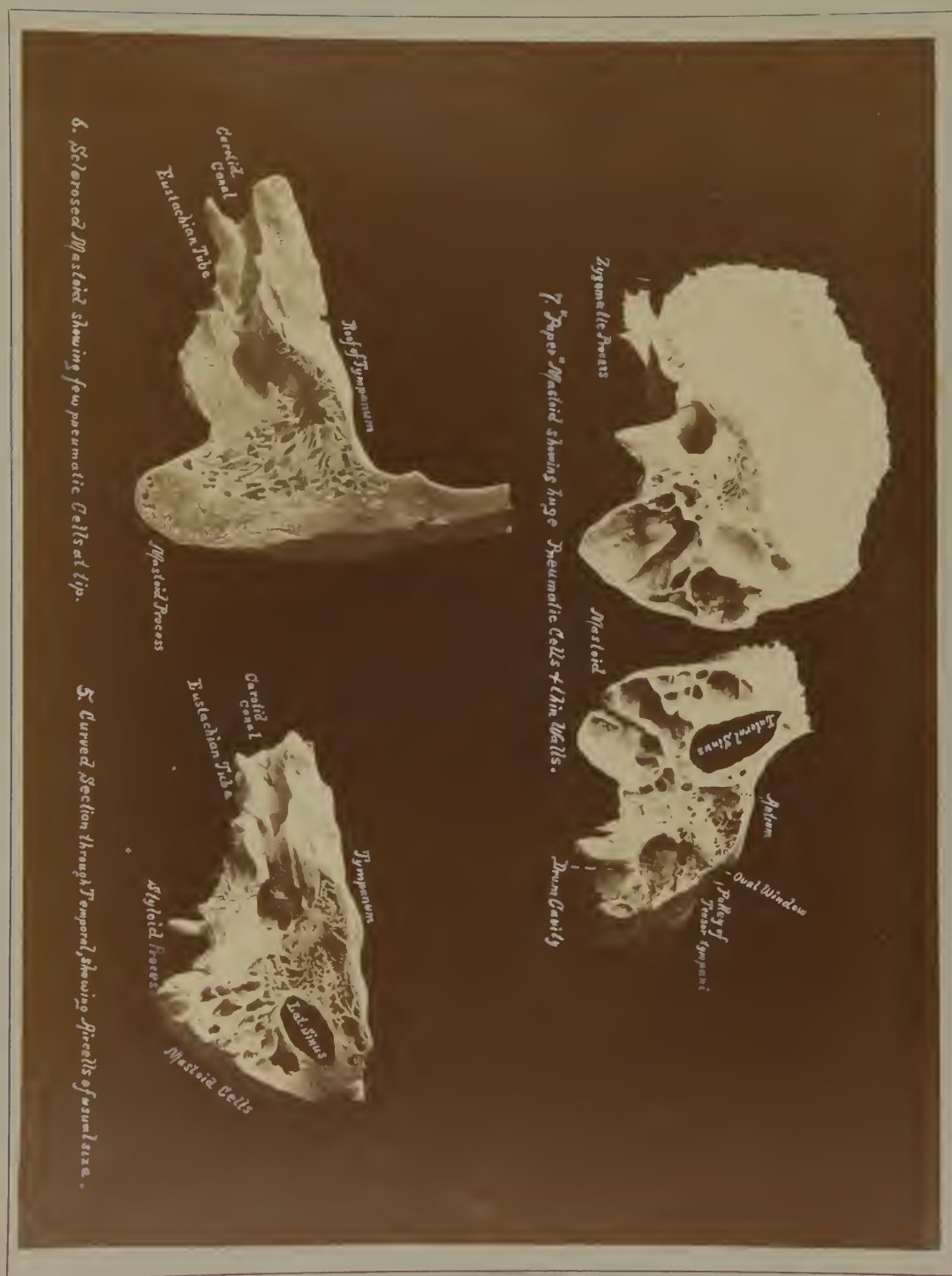
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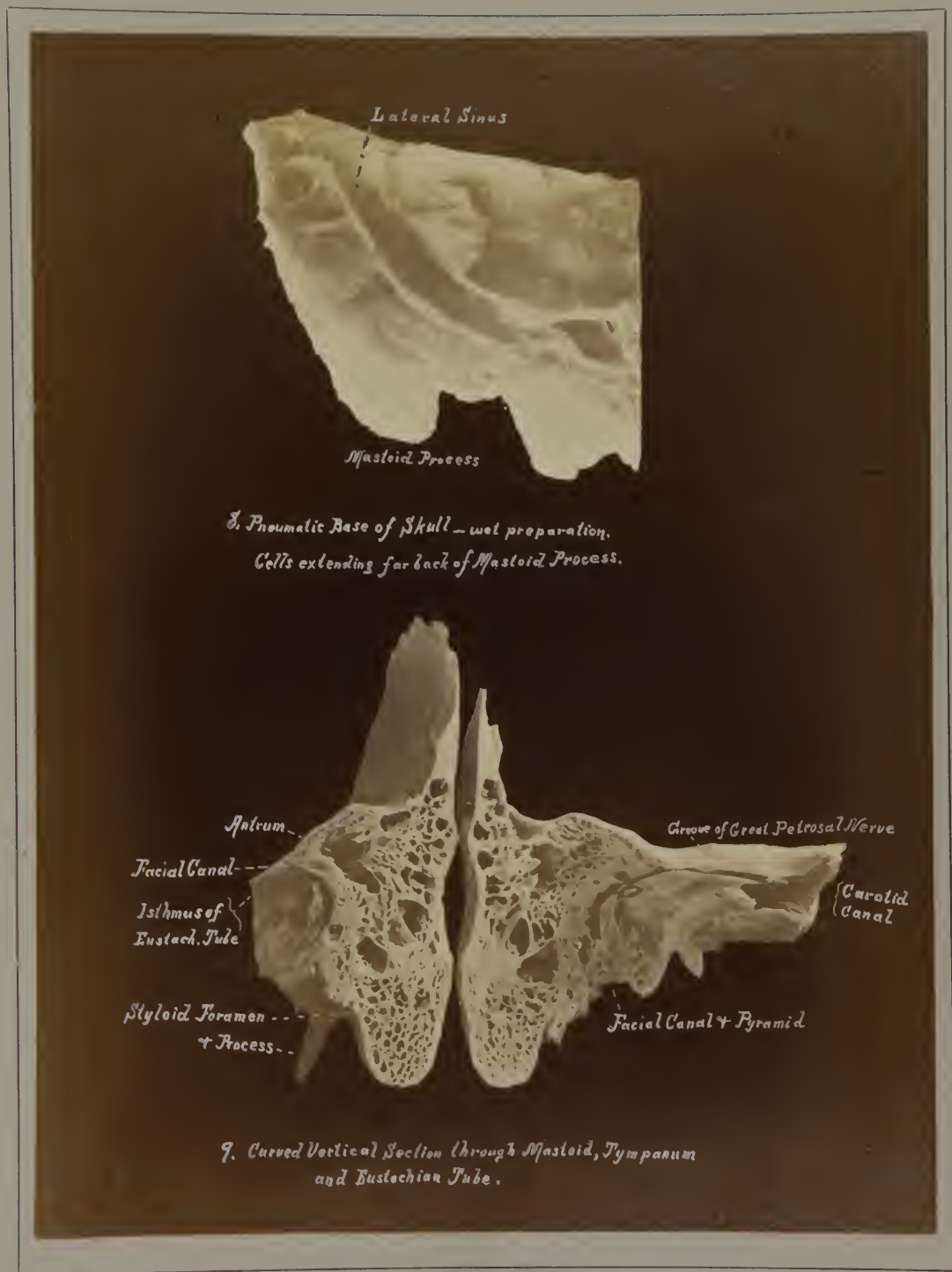
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6. Sclerosed Malleus showing few pneumatic cells at tip.

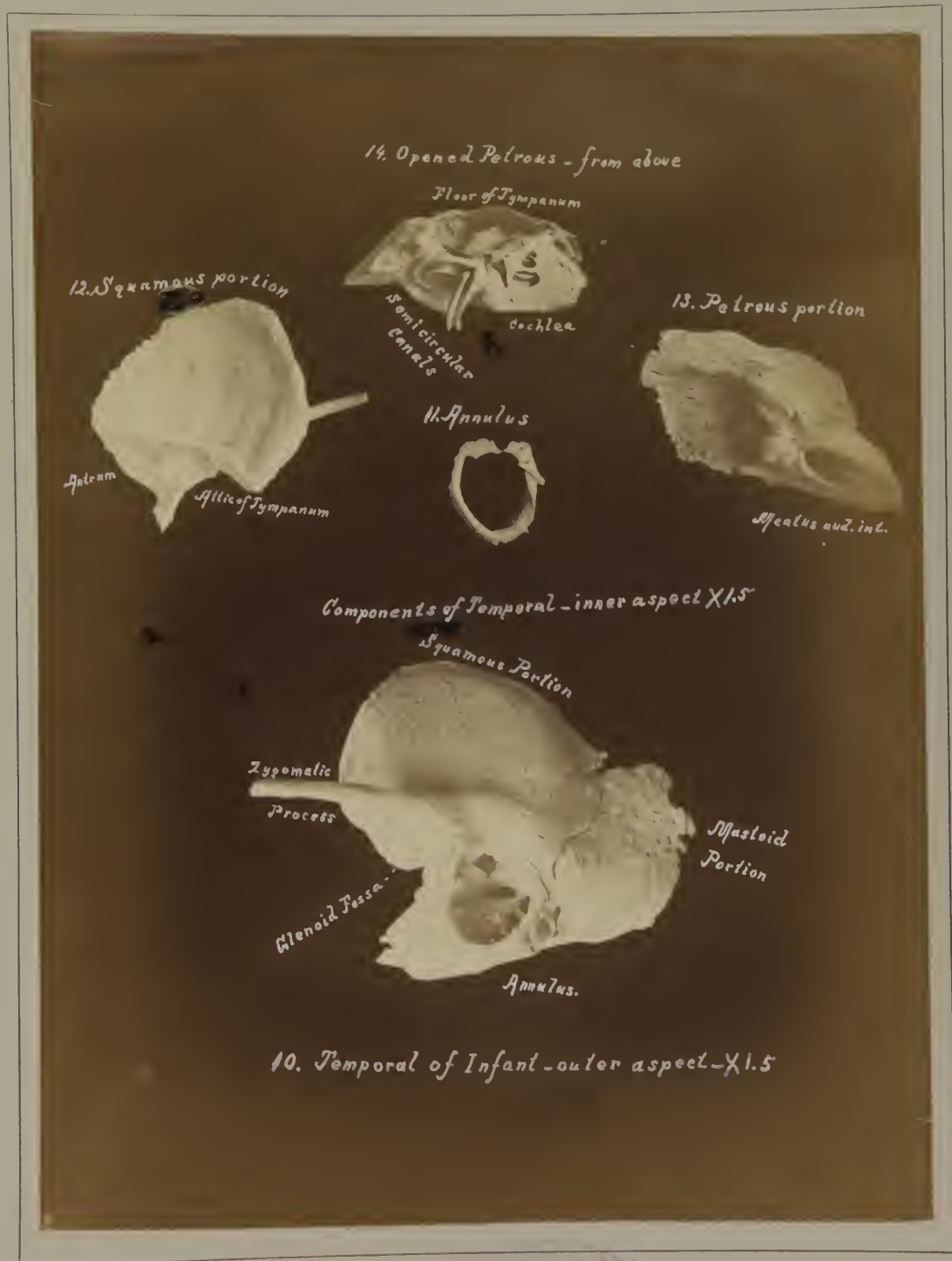
5. Curved Section through Tympanum, showing Malleus of usual size.

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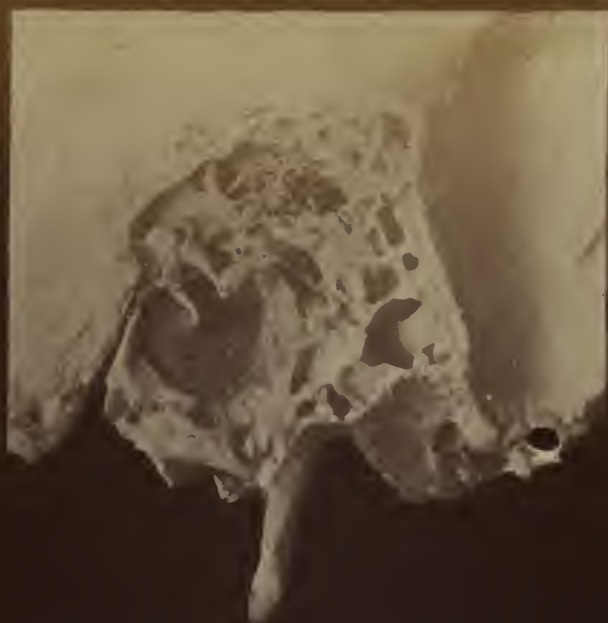
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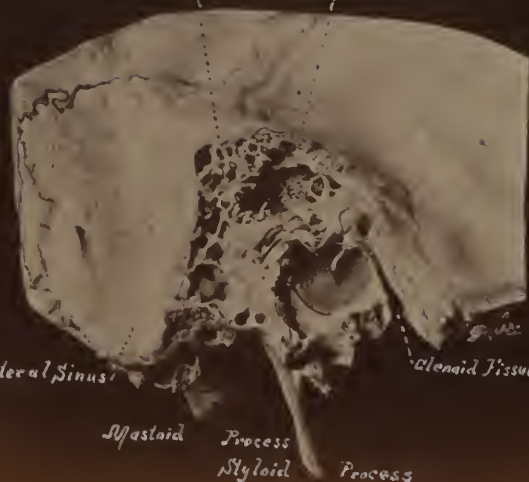
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16. Drum Membrane Ossicles &c. X2.

Mastoid Cells Antrum



Suleus of Lateral Sinus

Glenoid Fissure

Mastoid

Process

Styloid

Process

15. Temporal opened to show Drum Membrane, Ossicles & Antrum.

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17. Infant's Annulus, Drum Membr., Malleus & Incus. X 4.

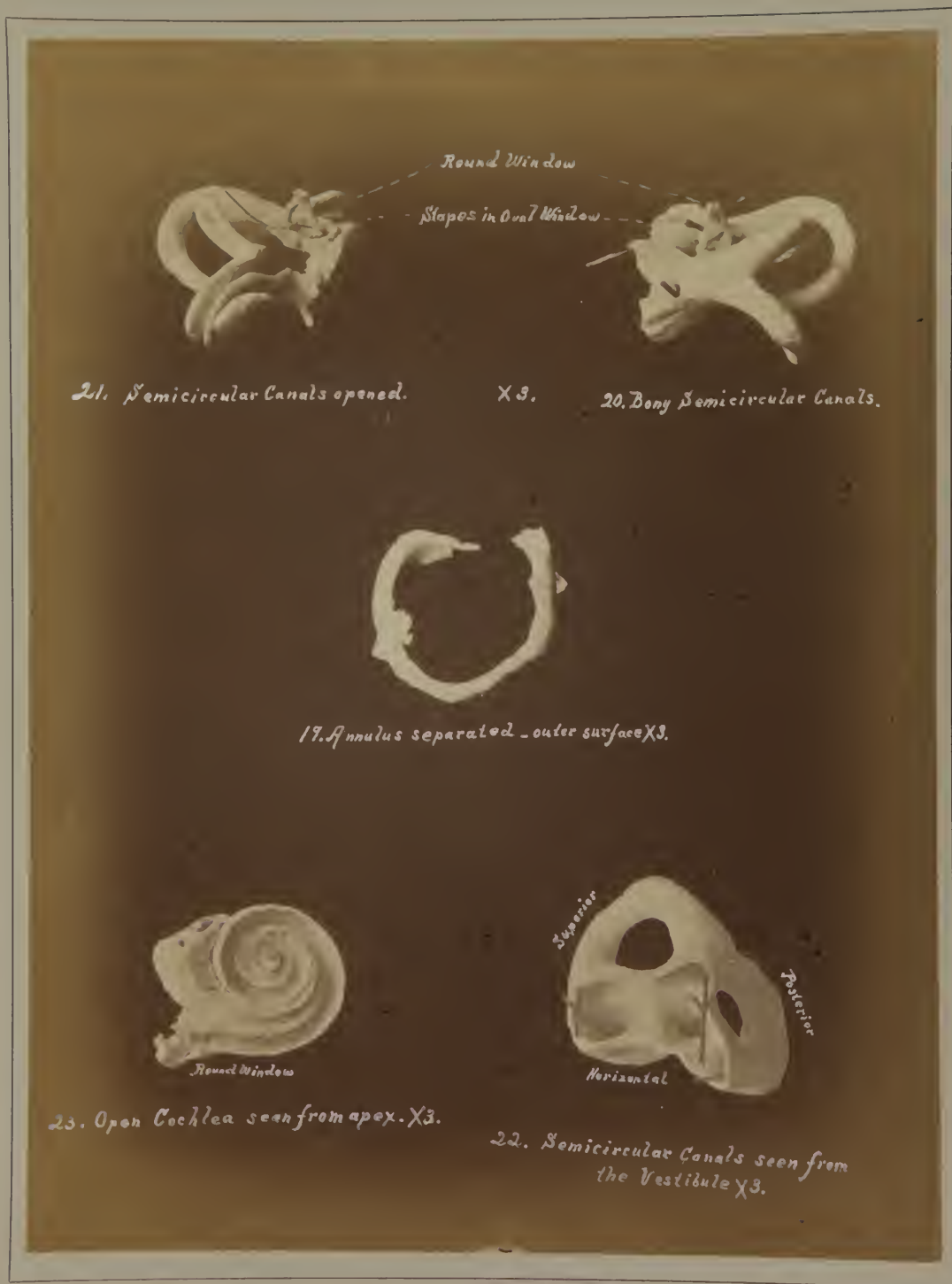


18. Infant's Annulus & Ossicles - from within. - X 3.

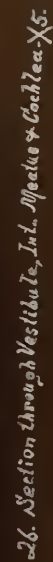
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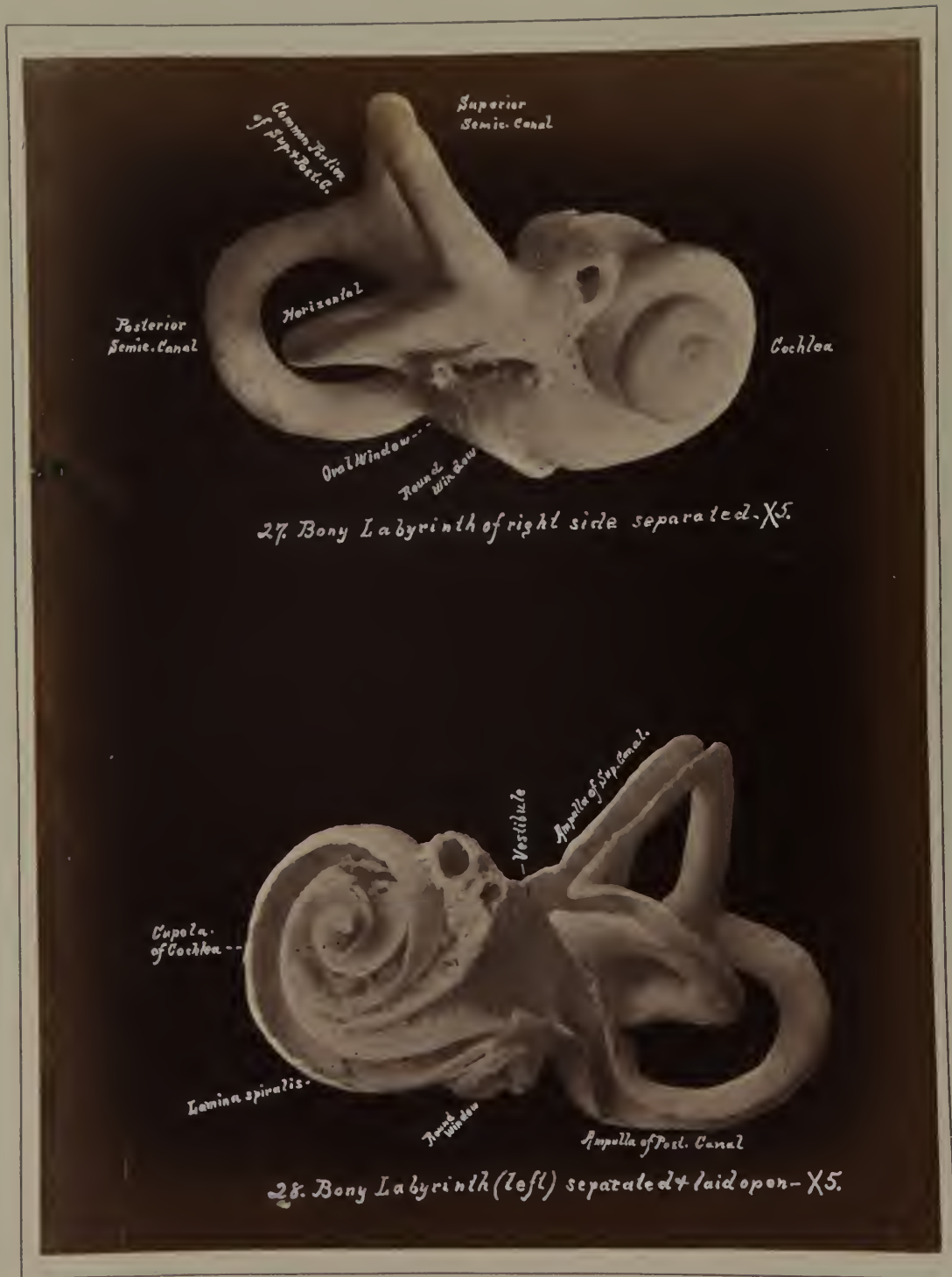


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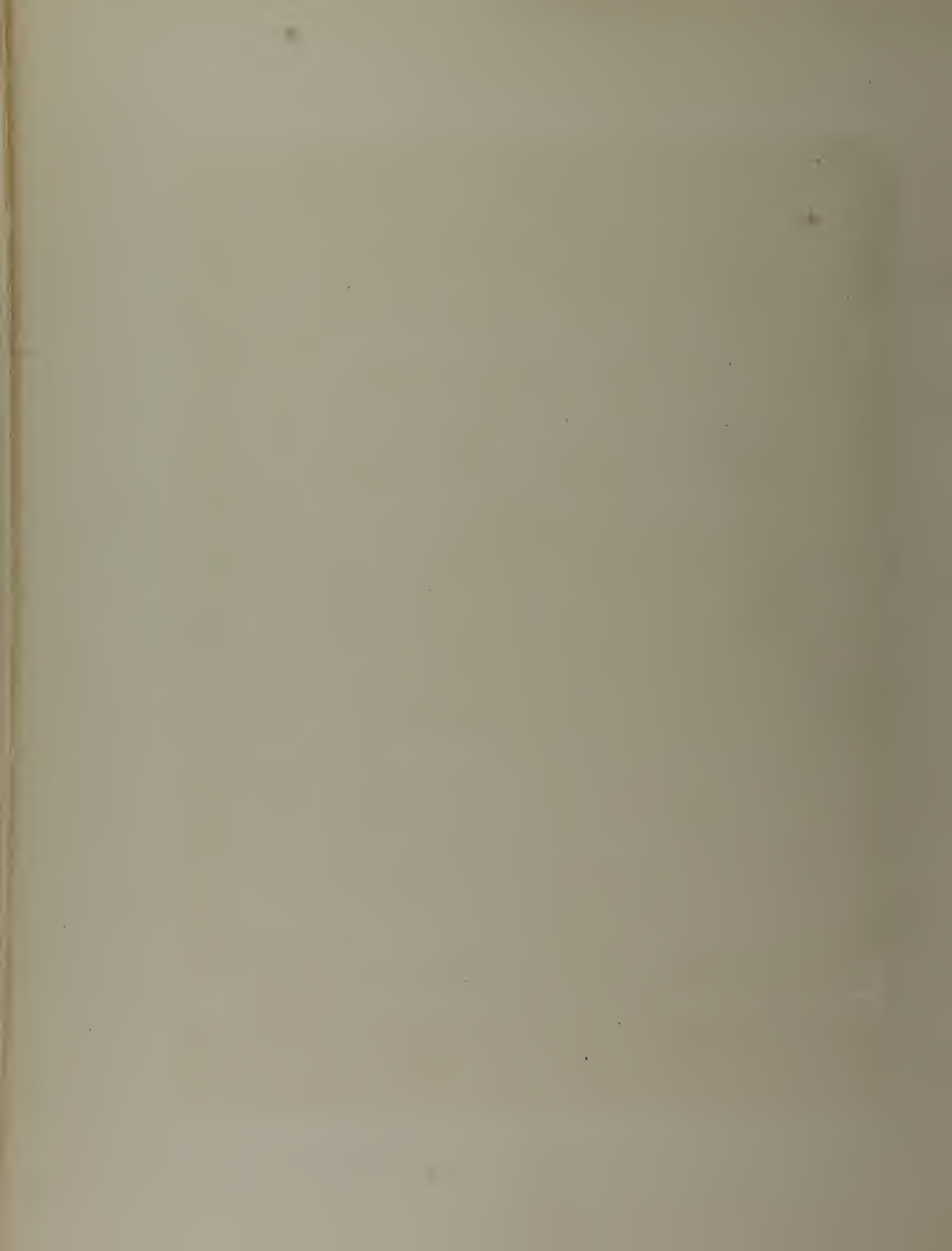


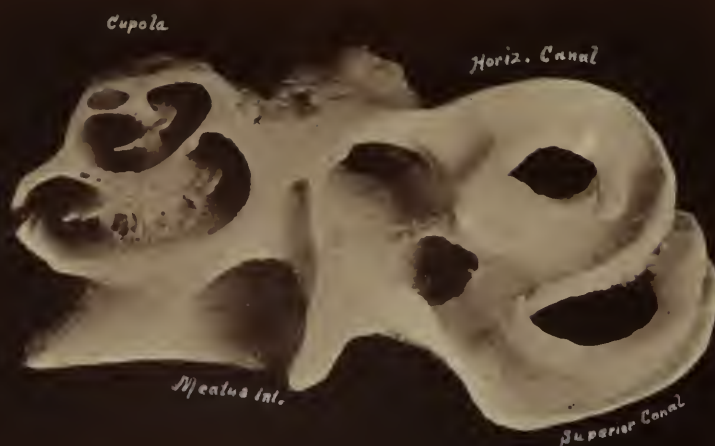
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29. Section through Int. Meatus & Labyrinth X5.



31. Infant's Cochlea, separated - X4.



30. Base of Cochlea & Bottom of Meatus int. X4.

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32. Annulus, Oval, Ossicles & Labyrinth seen from above. - X 3.5.



33. Annulus, Ossicles & Labyrinth, from above X 3.5. Showing Tendon of Stapedius Muscle.



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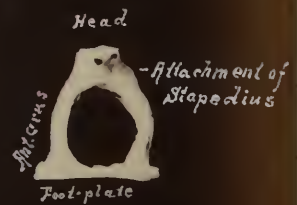
34. Set of Ossicles, articulated X6



Malleus

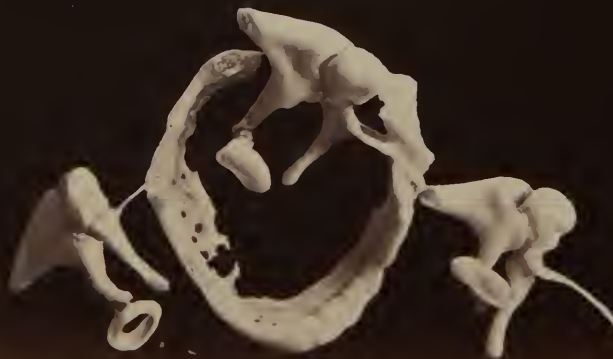


Incus



Stapes

35. Set of Normal Ossicles disarticulated - X5.5 Diam.



36. Annulus + Sets of Ossicles - X3.

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Malleus

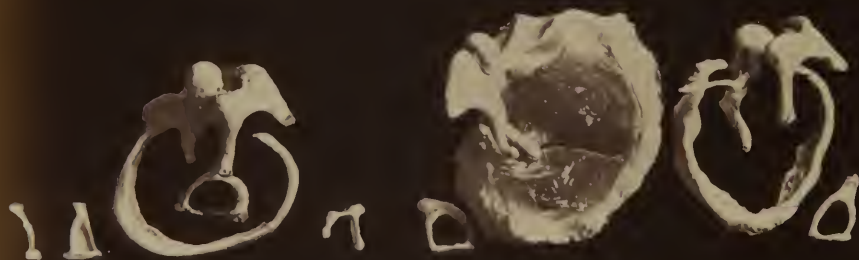


Incus



Stapes

37. Set of Ossicles showing Caries of Malleus & Incus X 5



Deformed Stapes

Bicaudate Monster.

39. Anomalies of the Annulus & Ossicles from Monstrosities X 2.



Cyclops Monster

Anencephalic Monster

38. Anomalies of the Annulus & Ossicles from Monstrosities X 2

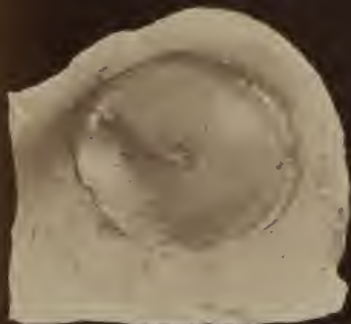
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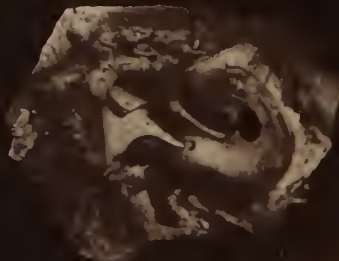
41. Ragged Perforation with Chalk in its Lower Edge X3.



40. Drum Membrane normal X3.



42. Small Perforation up Neck, Chalk below X3.



43. Small Perforation of Drum-membrane X2.



45. Calcification & Perforation X3.



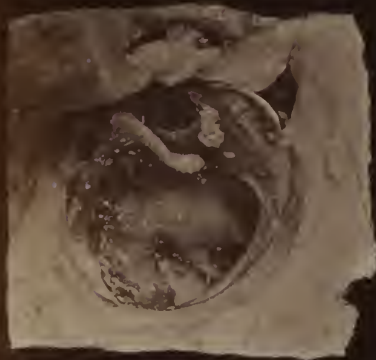
44. Perforation & Chalky Deposit X2.

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46. Double Perforation. X3.



48. Triple Perforation with Chalk Deposit X3.



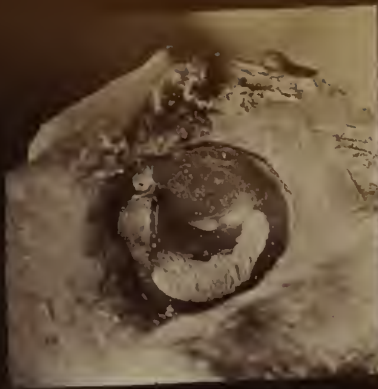
47. Double Perforation of M.E. X3.



50. Scattered Chalk Deposit. X3.



49. Perforation & Cicatrix X3.



51. Dense Chalk Deposit & Cicatrix X3.

134572-
M16.





54. Destruction of malleus and incus. Fast to drum. X3.



53. Circular fistula at upper pole. X3.



55. Destruction of upper part of external tube. X3.



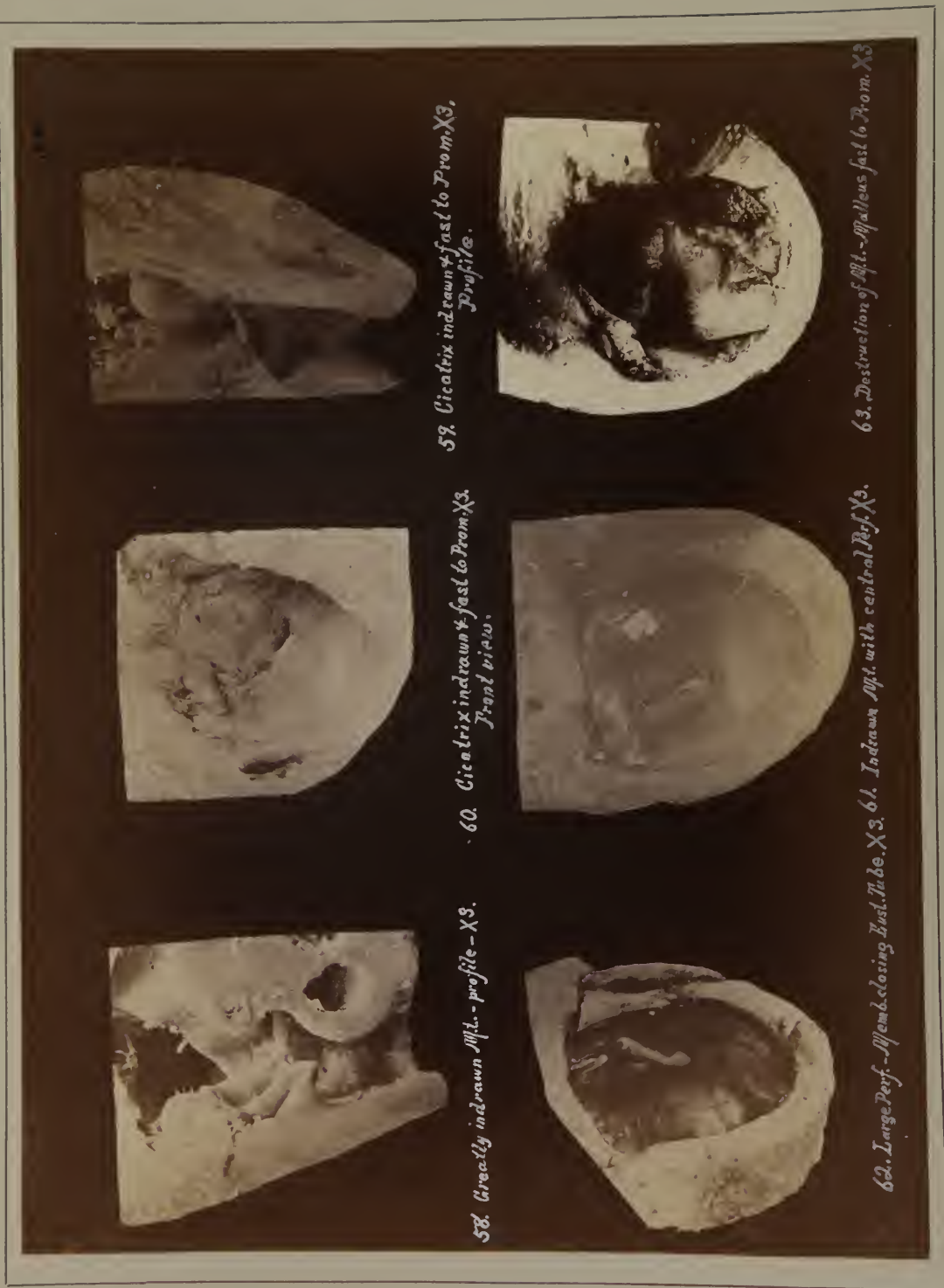
52. Extensive Destruction of ossicles. X3.



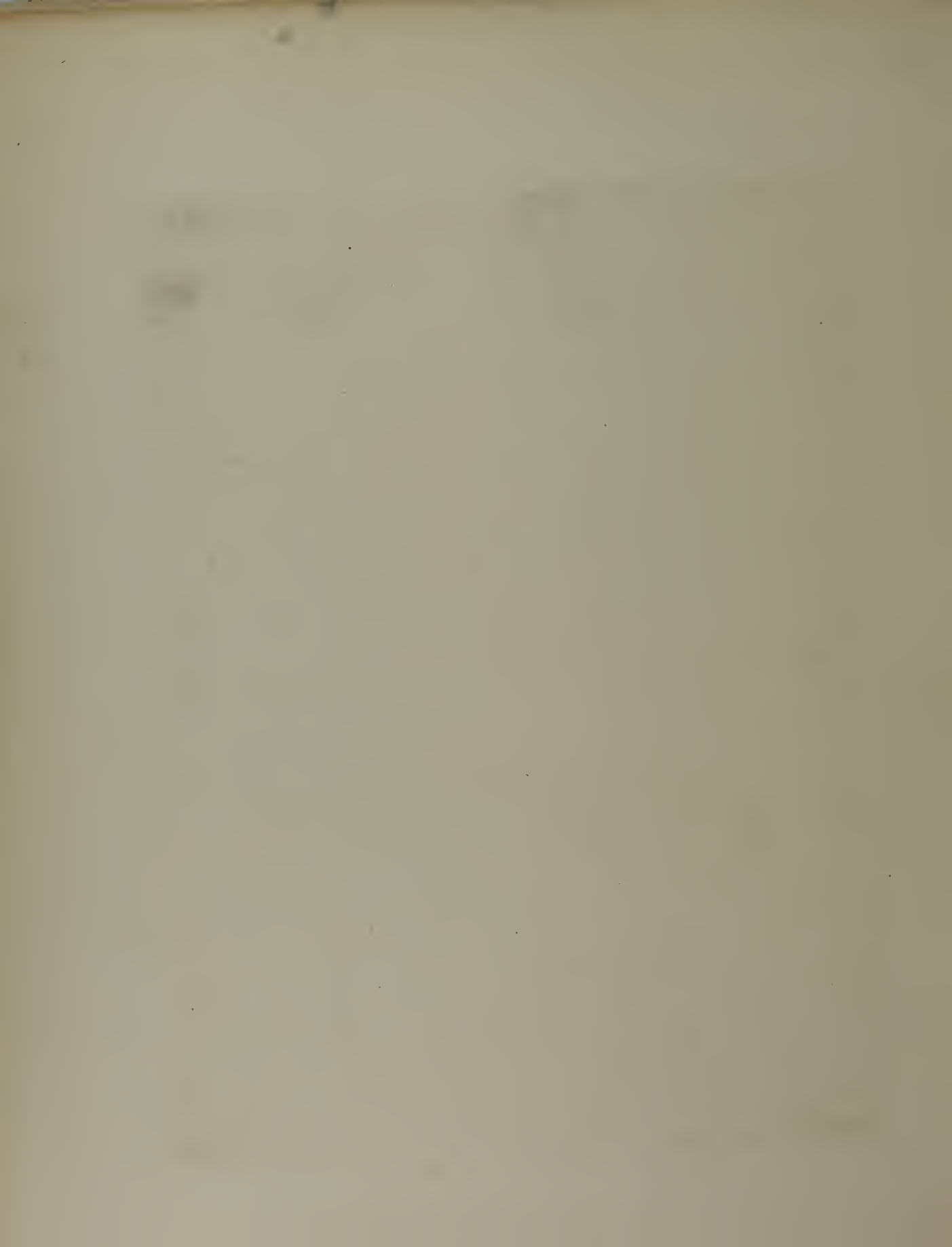
57. Varieties above malleus and incus. X3.



56. Bony ankylosis of ossicles. X3.



134572-
N. 18.



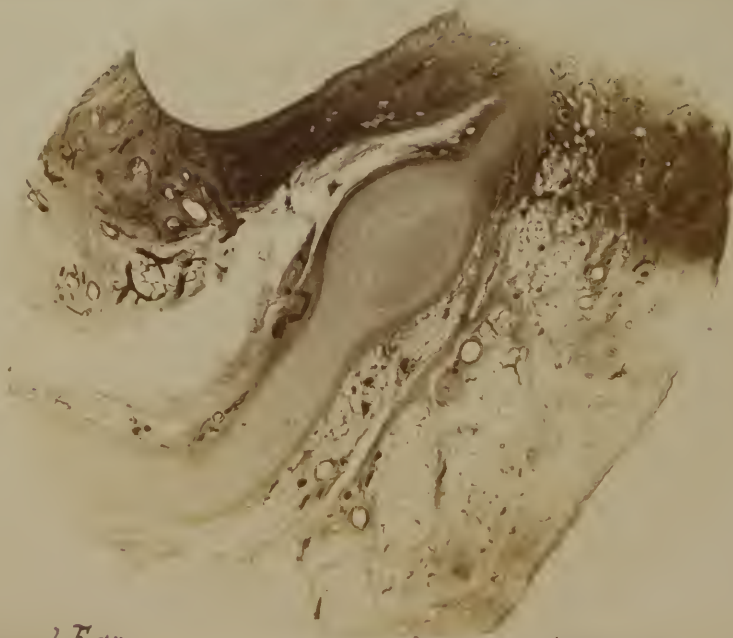
65



Cartilaginous External Canal.

- transverse section - X 14.

64



Tip of External Ear.

- transverse section - X 14.

134572
No. 19.



Drum membrane (Membr. propria) -

- flat preparation - X 25.

66.

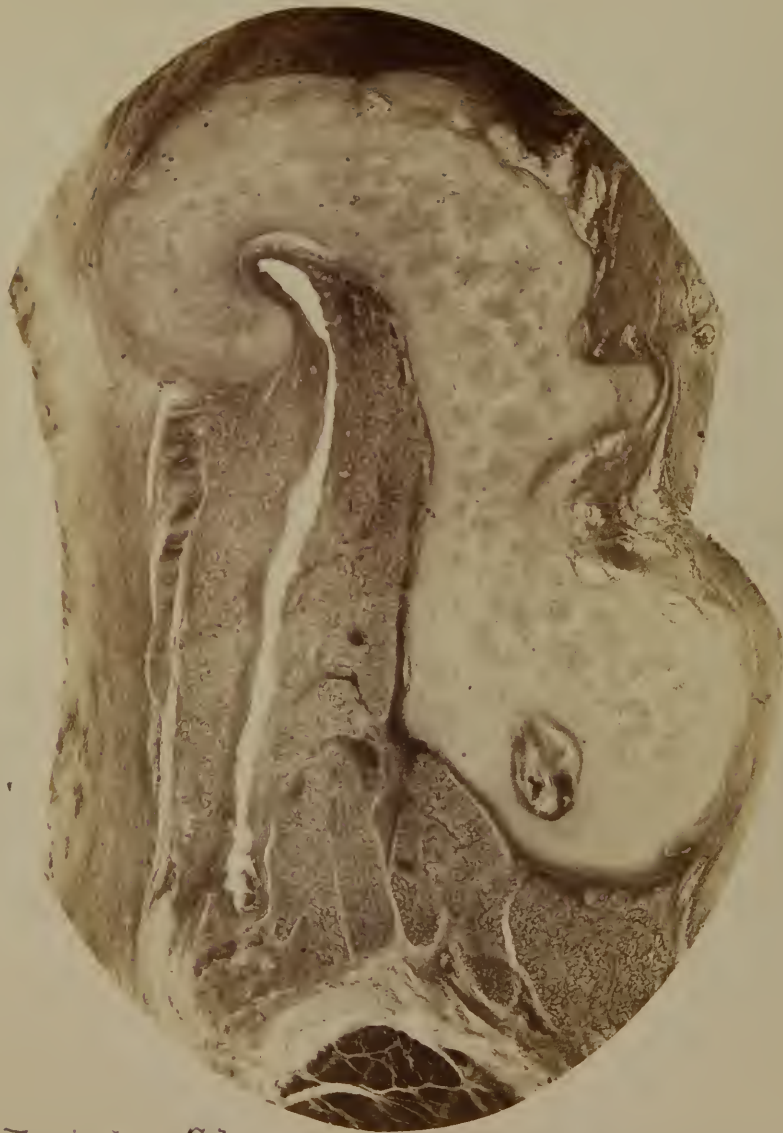


Drum membrane & Malleus handle -

- horizontal section - X 14.

134572
m. 20.





68. Eustachian Tube -

- transverse section - X16.

134572-

N^o 211



70.

Membranous Semic. Canal & Ampulla.

- flat preparation - x 20.

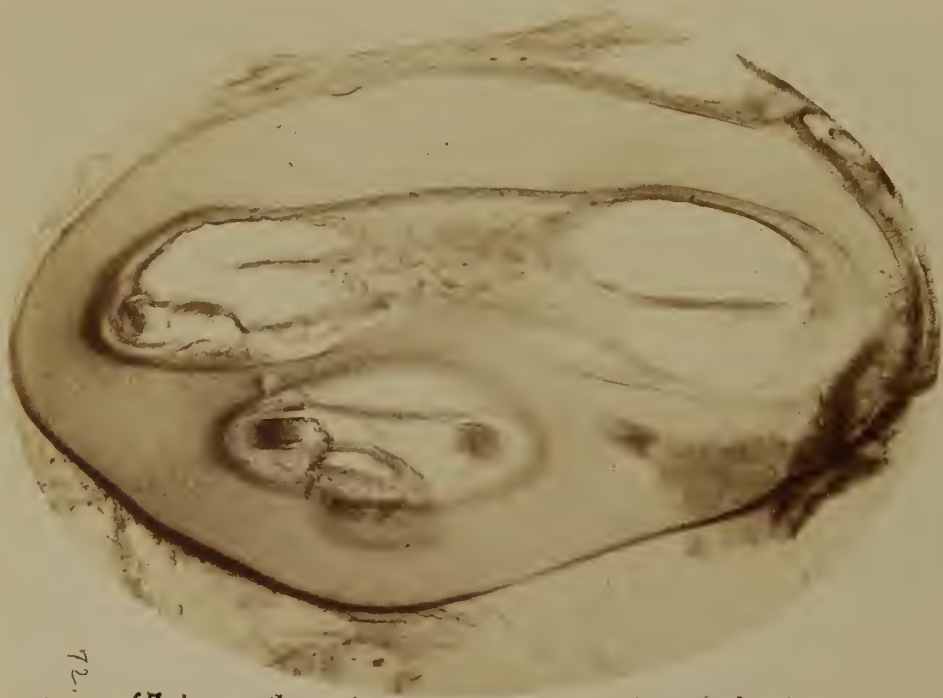
69.



Membranous & Bony Semicircular Canal - transverse section - x 20.

134572

N^o 22 -



72.
Cochlea of Embryo in 4th month -

- longitudinal section - x 18.

71.

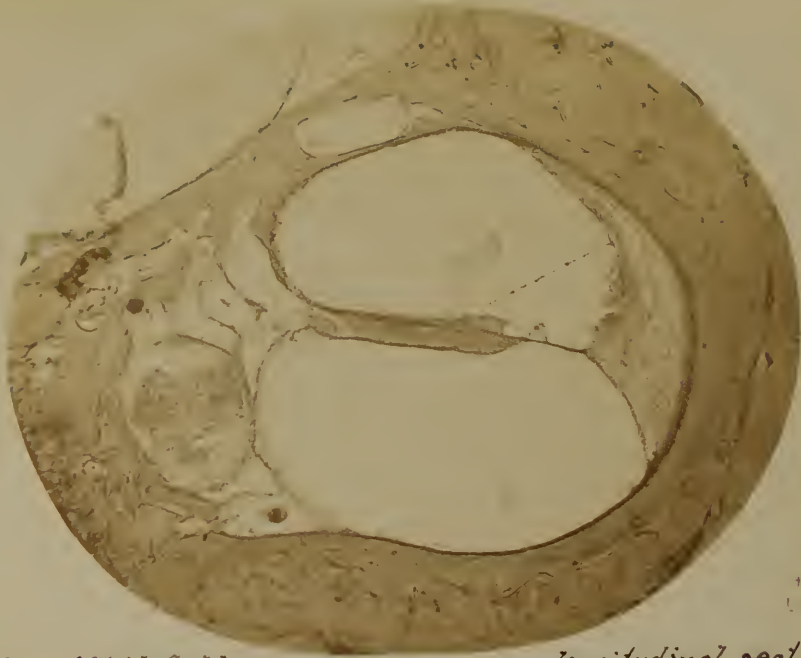


Malleo-Incudal Articulation -

- horizontal section - x 18.

134572-

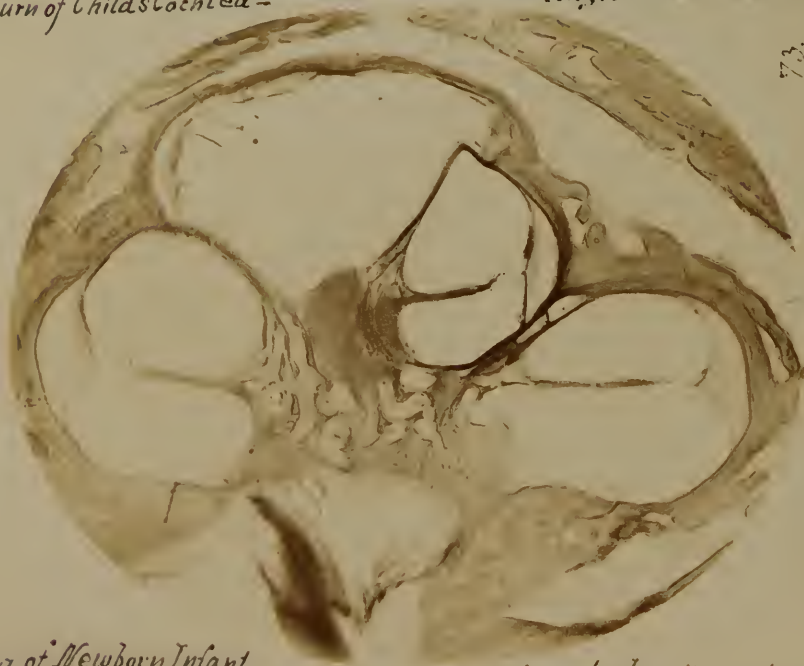
Pl. 23 -



Single Turn of Child's Cochlea -

- longitudinal section x 30.

73.

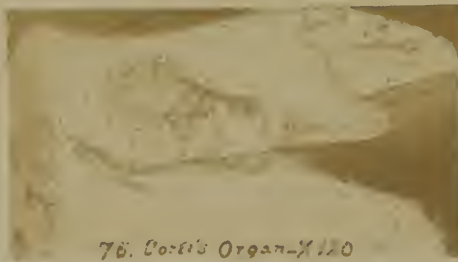


Cochlea of Newborn Infant -

- longitudinal section - x 16.

134572 -
11,24,

Photographic Illustrations of the Anatomy of the Ear.



76. Coe's Organ-X120

134572-
m25-

